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"Team Decision Making in Time-Sensitive Environments"

(Topic Area: Decision Making and Cognitive Analysis)

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Team Decision Making in Time-Sensitive Environments

Abstract

Many critical Command and Control decisions, such as Time-Sensitive Targeting, must be made collaboratively due to the amount of information to be processed and the level of complexity. This research addresses the challenges of technology-supported human collaboration. We have conducted a blend of field observation, expert interviews, and chat analysis at several joint, time-sensitive exercises and experiments.

We find operator teams perform critical functions as part of the human-technology "cognitive functional system." For example, they:

- validate information, and determine where to get more if needed
- engage in collaborative sensemaking – handling ambiguous or conflicting information
- establish trust and credibility with one another
- maintain sufficient team awareness to enable effective coordination, even when not co-located
- judge who should – and should not – receive information, balancing the need for sharing against the danger of cognitive overload
- select appropriate communication modalities for sharing information of varying importance, time-sensitivity, and intended audience
- cue other team members to important information, emerging events, or changing priorities.

Our results reveal how challenging these functions can be for operators bombarded with information, how existing technology supports or hinders key activities, and how teams adapt their processes or technologies to meet real time demands.

INTRODUCTION

Despite the many advances in technology, human collaboration and team decision making remain challenging and time-consuming activities in complex military domains. In fact, a recent study of Time Sensitive Targeting (TST) processes during Operation Enduring Freedom concluded that "Complex decision making processes consume a far greater proportion of the TST timeline than do communications between sensors, shooters, and other TST process components." The report articulated the need for "an assessment mechanism that allows for the human factors involved in decision making when complex issues are involved" (Veridian, 2003).

The goal of our research was to study teams of operators making decisions in realistic time-sensitive venues. We sought to understand the kinds of tasks and functions people perform in these collaborative environments, why the tasks are so challenging, how they are currently done, and how to better support team performance through improved technology and processes.

In military domains such as Time Sensitive Targeting, both the particular technologies used and the individuals involved in collaborative decision making are constantly changing. Therefore, instead of researching how operators interact with one particular technology, or how one specific decision is made, we chose to observe and analyze the broader team decision making process as it unfolds in situ. This more ambitious objective meant we had to find a means to address the *multiple* tools and technologies that operator teams use to inform their judgments – to include domain specific applications tailored to particular operator roles, more generic technologies such as instant messaging and email, face to face conversations, large wall displays, and phone calls. Key questions we sought to answer include,

- What are the fundamental activities, patterns, and challenges in the collaborative process?
- Where does technology support or inadvertently hinder decision making, and why?
- Do available technologies work together in a complementary fashion, or are they difficult to use in combination?
- Are the sources of needed information – whether machine or human based – transparent to operators and easily accessible?

DATA ON TECHNOLOGY-SUPPORTED TEAM DECISION MAKING

To adequately capture the interactions of people, processes, and technology in context, we developed a coordinated blend of three approaches: direct field observation of operators, expert interviews, and analysis of instant messaging or "chat" logs.

Direct Observation

In direct field observation, we serve as unobtrusive observers and are co-present with operators in their normal work environment. This is consistent with ethnographic observation (Nardi and O'Day, 1999) and contextual inquiry techniques (Holtzblatt and

Jones, 1993). We had successfully used observation techniques in previous military environments (e.g., Swanson, Drury, and Lewis, 2004). Over 2004, we gained access to several Time Sensitive Targeting-related exercises and experiments that closely resembled the actual operational work environment. With permission from the operators, we placed ourselves near enough to hear conversations, see tool placement and usage, observe when operators phoned or got up to speak to others, and detect more subtle body language suggesting frustration, confusion, fatigue, or other mental and emotional states. We looked over their shoulders in order to document which applications they used, and how. In some cases, operators even invited us to listen in via dual headsets to hear those communications in real time.

Direct observation is valuable for monitoring the full communication spectrum, from individuals typing into chat windows to face-to-face discussions and phone calls. It also enables detection and documentation of physical cues (facial expressions, joking, banging on the table, etc.) that can reveal emotions or cognitive states. Another benefit of field observation is the immediacy of the data; team interactions and activities are captured as quickly as we can note them on paper so the latency relative to actual events is negligible. A primary disadvantage of directly observing operators in the field, however, is that a few observers cannot possibly attend to all team members and all activities at once; it is very difficult to capture an entire collaborative thread using this approach, especially if the team is not fully co-located. In classified environments, audio or visual recordings are not permitted so field observations must be recorded by hand.

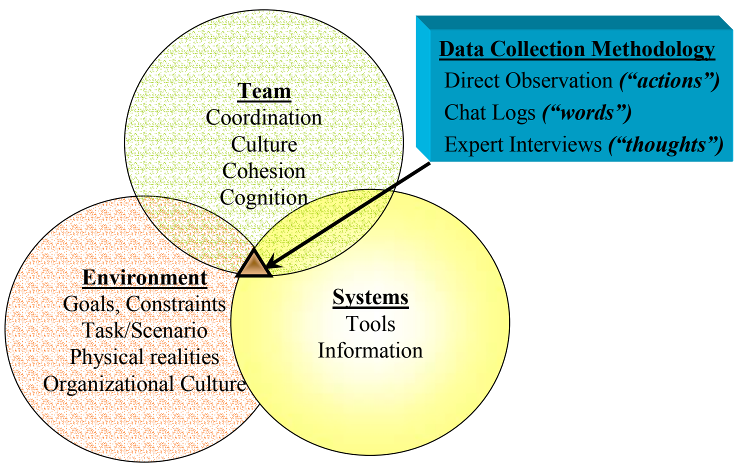

Figure 1. Data for Analyzing Technology-Supported Team Decision Making

Expert Interviews

We also gathered data via structured interviews. We focused on operators with extensive experience in the field who could provide insights based on their years of domain experience. During interviews, we solicit their rationales, their judgments on the amount and quality of information provided, their success stories or perceived challenges involving information sharing and coordination, and their perspectives on social issues such as the level of team familiarity, cohesiveness, and trust. It is critical that questions do not annoy or distract team members from their activities. Questions are typically asked before or after an exercise, or during a break in the action if an operator indicates it is acceptable.

Interviews provide important context for other types of data by revealing what an operator was thinking at the time of a particular activity. We can ask questions whose answers would be impossible to infer from direct observation or chat logs, such as "What prompted you to ask for that information at that point?" "How did you know to share the information with those particular individuals?" "How did you reconcile those conflicting pieces of information?" "Can you tell us why you double-checked that particular source?" Unfortunately, interview responses are by definition subjective. They are filtered through an individual's frame of reference, cognitive processing, and memory. Interview data can suffer from hindsight bias or rationalizations, as well as latency issues when questions are asked in retrospect. It is therefore important to combine interview data with other sources.

Chat Log Analysis

In conducting chat analyses, we log and comb through the text of instant messages sent from an individual to other individuals or to the members of "chat rooms". These rooms are organized along convenient topics and subgroups such as time-sensitive targeting, weapons, intelligence, or internal coordination. Each operator joins the subset of chat rooms he deems most useful for his individual tasks, and for his information sharing needs with others on the team.

Data from chat logs have the advantages of immediacy and objectivity; messages are captured word for word as they occur in real time so there is no bias or time lag between what occurred and what is recorded. The clear documentation of senders, recipients, information content, and time stamps allows for the re-creation of collaborative threads across multiple participants from beginning to end. Unfortunately, chat logs do not reflect the other modes of communication that were occurring simultaneously. Compared to interview data or observational data, chat logs offer a limited view into operator motivations and the environmental context surrounding a discussion thread.

Fortunately, we have found that data from field observation, interviews, and text messages used *in concert* create a powerful mechanism for understanding collaboration. For example, suppose we note an interesting field observation such as two people in heated discussion over a target, gesturing at a display. We would follow up by asking clarifying interview questions during a break in the action, such as "Can you tell us more about your discussion with operator x at time t?" "Was there a difference of interpretation?" "Was the information you needed available?" We would also check the relevant chat logs surrounding that time to see what those two people were trying to understand or decide. As shown in Figure 1, the combination of observation, chat and interviews – in essence, people's actions, words, and thoughts, respectively – helps us capture the intersection between the teams of operators, their available systems, and their complex environment.

FINDINGS

We collected field data from numerous joint exercises and experiments in 2004. The commonality was an emphasis on the team of operators engaged in Time-Sensitive Targeting decisions. In these scenarios, an unplanned target emerges and the team must locate and track it, redirect intelligence, surveillance and reconnaissance assets in order to determine the exact nature and importance of the target, and potentially identify and redirect an appropriate weapons platform to engage the target – all within a short time window. These teams must typically work across service boundaries, or even across coalition nation boundaries, in order to effectively cover an area of responsibility and bring all necessary assets to bear.

It is common to think of human operators as having primarily an "information processing" role - gathering, transmitting and analyzing information much as computer systems do (albeit with greater susceptibility to error and biases). While information processing is certainly a key piece of the human role, our research has highlighted several more complex and subtle roles that humans play. These functions are vital for knitting all the pieces of information together in context, and typically require the ability to make multi-faceted judgments, to handle ambiguity, and to be adaptive. Below, we describe some of the critical functions that operator teams perform. They:

- validate information, and determine where to get more if needed
- engage in collaborative sensemaking – handling ambiguous or conflicting information
- establish trust and credibility with one another
- maintain sufficient team awareness to enable effective coordination, even when not co-located
- judge who should – and should not – receive information, balancing the need for sharing against the danger of cognitive overload
- select appropriate communication modalities for sharing information of varying importance, time-sensitivity, and intended audience
- cue other team members to important information, emerging events, or changing priorities.

Determine trustworthiness and reliability of information, and where to get more

We observed many instances where human operators served the critical function of vetting information to determine its trustworthiness and reliability before acting on it. This is particularly important in the kind of decision making context studied here in which ambiguities regarding enemy targets, rules of engagement, and priorities abound. As one interviewee commented, "It is important to sort out what information really matters and to verify the source of the information before acting on it."

For instance, people sometimes double-checked information that was surprising in context. In one instance, a Lieutenant was surprised to see an order for an Unmanned Aerial Vehicle (UAV) to return to base because it was just about to provide video for Battle Damage Assessment (BDA) on a target. ("RTB[2]?? Just when we were seeing impacts?") This type of proactive human verification avoided potential errors or misunderstandings. It is a difficult function to automate because it requires an understanding of the broader context, namely that in this case there was an imminent expectation of a desired result (video to indicate whether the target had actually been destroyed) and the return to base request, if correct, would prevent that outcome.

In other cases, people requested verification of the *source* of the information before they determined how to respond. In the case of the surprising RTB order noted by the Lieutenant, her Lieutenant Colonel wanted to know the identity of the person who gave the order via chat ("Who is SAC [chat identifier]?"). In other cases, we observed operators requesting a seconding of important information in order to establish it as trustworthy (*Have you guys seen any intel[3] on this target?*). Their experience and personal relationships with others on the team informed these judgments ("In the past, he has provided very reliable intel.").

When operators saw information that was surprising, confusing or incomplete, they generally took the initiative to get clarification. An important component of this information verification and validation process was knowing <u>where</u> to go for the additional information. Although we might expect or hope that the sources of all types of information would be predetermined and known, this is not typically the case. Because there is so much information coming from so many sources in so many forms, and because it may be processed or updated by many systems and people, it is often challenging to find the needed information under time pressure. As some operators explained when interviewed, "It takes experience to know where to get the right information." "It's usually there, but knowing where to look is key."

As a result, the power of the informal social networks that teams created became apparent. Operators called or emailed one another for guidance; teams with experience working together typically knew "who to call" to get the needed information, or at least a pointer to it. With less experienced teams or more novel situations, people used chat to "information shop," in which case they broadcast a request for the desired information (*Does anyone know where I can find out about…?*).

Despite operator creativity and social networks, we observed instances in which the desired information <u>did</u> exist but operators did not find out about it until after the fact. ("I knew there was probably a file on this, but I couldn't find it in time.") There are many opportunities for improved information management; the information must not only exist, but be transparently available and easily accessible.

<u>Engage in collaborative sensemaking</u>

As previously described, people often play an important role in verifying information before acting on it. This becomes even more challenging when, despite verifying its source and provenance, the information remains fundamentally ambiguous or even conflicting. In these cases, the team must engage in collaborative sensemaking.

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[2] RTB = Return To Base

[3] Intel = intelligence

What does the information really mean? What are the implications within the current context? What effects might be anticipated?

For instance, we observed a team working with a UAV in the vicinity of two airfields. The information coming from the UAV's video was deemed valid and reliable, but didn't make sense to some members of the team ("Is that the wrong airstrip? NorthTAC is at the base of a ridge and I don't see any of the ridge in the video."). The team struggled to interpret the information and its implications in context; did it mean the UAV was flying over the wrong airfield, as some thought, or that it was directly over the expected ridge making it impossible to see?

In other cases, the rules of engagement did not unambiguously specify what did and did not qualify as a dynamic target, and whether it was acceptable to engage a particular target. In one instance, a lively back and forth discussion ensued via chat, phone, and face-to-face before the commander made a judgment call. As one operator put it, "Rubbish in, rubbish out. You've got to have a human in the loop when there's ambiguity."

<u>Establish trust and credibility</u>

Another function human operators perform is the establishment of trust and credibility between members of the decision making team. This plays a critical role in their ability to collectively validate incoming information, and to effectively resolve differences of interpretation when information conflicts or is unclear. In time pressured scenarios, the absence or presence of interpersonal trust and credibility can be the determining factor in which personal opinions and supporting system information get full consideration.

We observed a team interchange in which this mutual trust was lacking. A lower ranking Master Sergeant tried to alert others on the team that a UAV was over the wrong airfield, with very little time remaining to take corrective action. He pointed out the expected but missing ridge in the UAV video and convinced his Lieutenant that his interpretation was correct; she had a Staff Sergeant radio this message to the Major in charge at a nearby but separate location. The Staff Sergeant was rebuffed, and reported that "they are too busy to listen right now." The Lieutenant then tried to deliver the message herself face to face, but was also unsuccessful. Under severe time pressure, the Master Sergeant and Lieutenant's perception of the situation was discounted as less credible than others, and so was the system information they referenced in support of their position.

It takes significantly more time and effort to establish trust and cohesiveness across organizational boundaries, since corresponding team members will typically not be co-located, not know each other well, and not share all of the same goals, values, priorities, procedures, and social or cultural conventions. During one experiment we attended, a potential target being tracked would have required sharing of assets between the Air Force and Army should it be engaged. The Air and Land Component Commanders were geographically separated. As the Time-Sensitive Targeting team followed this potential target, we observed their team leader monitoring the Land Component Commander's status on a display of coordinated activities. He proactively contacted his Army counterparts the several times via phone and chat although no immediate actions were needed. When interviewed about these communications, he explained that he wanted to "get them energized" and "ensure buy-in" and coordination before the potential target in question became a Time-Sensitive Target. He recognized that shared situation awareness and a relationship of trust were critical and couldn't be immediately established at decision time.

Maintain sufficient team awareness

In order for operators to effectively share information, coordinate activities, and create shared *situation* awareness, they must maintain "*team* awareness." This involves knowing the identities of others on the team, the activities they are engaged in, what they know and do not know at a given time, whether they are present at their stations at a given time, and how busy they are. Without this awareness, they may share information inadequately or excessively, misinterpret a response or a delay in receiving one, and lose trust or shared situation awareness.

During one event, two team members were observed having an animated face-to-face discussion regarding a target they had not engaged in time. There was confusion as to whether it had been missed inadvertently, or deliberately, and the rationale. ("Did we know about these SCUDS?" "Yes, but ROE[4] didn't let us attack." "Oh, we didn't know you knew!") In another instance, a team leader expressed the importance of awareness of team members' workload and cognitive load when coordinating on tasks: "I need to know if other people on my team are overwhelmed. Are they? I don't know."

Maintaining team awareness is particularly difficult when the team is not co-located and cannot readily see or hear one another. In these environments, the team must use a mix of technologies, such as tailored coordination displays, phone calls, and instant messages, to keep abreast of others' activities. No single technology currently addresses the team awareness issue.

OPERATOR ADAPTATIONS OF TECHNOLOGY OR PROCESSES

Researchers have noted that although systems are typically designed with specific uses and purposes in mind, teams will appropriate those tools in whatever way best suits their goals and needs.

> *People are "purposive, knowledgeable, adaptive, and inventive agents who engage with technology in a multiplicity of ways to accomplish various and dynamic ends. When the technology does not help them achieve those ends, they abandon it, or work around it, or change it, or think about changing their ends"* (Orlikowski 2000, p.423).

Indeed, some of the most interesting lessons learned from observing technology-supported teams in situ involved ways people adapted either their processes, or their use of technology to meet demands in real time.

[4] ROE = Rules of Engagement

Attention Management

It was common for TST operators to have two computer displays each, with multiple application windows open on each window. The left screen typically contained an application for coordinating tasks across the team, as well as a map-oriented application displaying relevant tracks and targets. The right screen was commonly reserved for communication and typically contained half a dozen or more chat windows. Although the chat tool was designed to alert people to incoming messages by providing an auditory “ping,” this became ineffective in an environment with many chat windows, competing applications on the other screen, and constant interruptions from others. Operators were clearly struggling to manage their attention and maintain situation awareness when simultaneously bombarded with information from numerous chat windows and via various other modalities.

Some adaptive behavior involved chat in particular. In order to sort out what information among all the chat windows was new and what had already been read, one operator repeatedly used his cursor to manually highlight the bottom line in each chat window. Thereafter, any time a new message arrived it would replace the bottom line and the highlighting in that window would disappear; the chat room containing the new information became easy to identify at a glance as the one *without* highlighted text. Even if the operator had been looking at his map display or talking to someone when new chat came in, he could now quickly orient himself and identify the information needing his attention. Unfortunately, even this clever adaptation broke down if many new messages arrived simultaneously, or if the operator had to step away from his station for any length of time. The adaptive behavior met a short term need on a limited basis, but did not scale. It alerted us to a larger issue: operators are cognitively overloaded and require improved technologies for filtering information and directing their attention.

Cue other team members

The difficulty in keeping up with the flood of new information resulted in an adaptation of a process, as well as the previous adaptation of a technology. We observed operators self-organizing to voluntarily cue one another to important developments or changes that others might have missed. Team members took the initiative to note when others had either been away from their stations or otherwise preoccupied during an important event. When the team member returned, someone would inform him that an event or item of potential importance had been missed, and where to look to quickly get reoriented (“You missed some information on [target x] in [chat room y].”)

In addition to ensuring that information content itself was not missed, this voluntary cueing propagated meta-level information such as the priority of the information. The fact that a neighbor expended the time and effort to cue another to a piece of information implicitly communicated that the information was deemed important. Clearly the ability to cue others effectively requires sufficient team awareness, as previously described: the operator must understand that the information would have been relevant to the other team member, that he had temporarily been absent or overloaded, and that he was now available and capable of receiving it.

Judge who should – and should not – receive certain information

Information technology facilitates sharing more information more easily with more people, yet wider information sharing was not always beneficial given the cognitive demands of the operational environment. Since supporting technologies sometimes left operators with an "all or nothing" choice for information sharing, people developed strategies on the fly to balance the need for enough information sharing against the danger of excessive distractions or cognitive overload.

For instance, the TST team relied on an application that presented target information in a matrix format: each potential target appeared in a row, with associated columns and tabs for entering specific status, location, and intelligence updates. The cell chief used this application to keep tabs on all types of targets, including still unverified or "in the background" targets that might not require any action for some time. The accepted procedure was for him to project the target list from his screen onto a large wall display for use by the rest of the team.

While it was desirable to fully share information across the team on most targets, the cell chief found unverified "background" targets were a potential source of misdirection of the team's limited time, energy, and resources. Presented with an unsatisfactory binary choice between sharing his display fully or not sharing it at all, he adapted by projecting his display on the data wall but *manually hiding* the rows corresponding to the unverified targets. This required him to periodically unhide one of these rows to update the associated information, then quickly hide it again. This workaround met short term needs, but at the expense of extra time, effort and attention for the operator. Moreover, the approach quickly became impractical as the number of potential targets being considered increased. This interplay between operators and technology indicates an underlying need for a collaboration capability supporting more selective information sharing.

Select appropriate communication modalities for sharing information

We observed that operators not only had to determine *what* information to focus their attention on and *with whom* to share it, but also had to make countless secondary judgments about *how* to do so: what means of communicating will get the desired response most effectively?

For example, an operator could post information to a designated database or shared application, in which case other team members know where to "pull" the information from if needed. Another option was to "push" the information via face to face discussion or by phone, which guaranteed that the intended audience received the information but provided no documentation and did not scale to more than a few people. Instant messaging was another possible means of information sharing, in which case there were decisions to be made about the appropriate chat room(s) to address, or whether a *chat in private* directed at a particular individual would be more appropriate. Still another option was to use *audio* chat via the headsets, in which case the operator's comments would be immediately heard by the selected individual(s), if present.

Teams employed these various modalities differently, depending on the importance and time-sensitivity of their communication and the intended audience. Posting target information to the appropriate shared application was part of the planned process and effectively accommodated highly structured information such as latitudes and longitudes. Sometimes this form of communication was supplemented by phone calls or text messages to alert others that new information was available.

Text chat was commonly used when a communication had to reach many interested parties quickly, and/or when it was judged beneficial to have a written record of the information for later reference. However, since operators were typically logged into six to twelve chat rooms each, and some of these rooms had large numbers of participants, the amount of information in chat rooms could become overwhelming and unfocused. As a result, many private chats between pairs of individuals spun off from the main chat rooms so that two people could expand on a thread without cluttering the main room (*Request CIP*[5] *with you*).

When information was particularly important or time critical and immediate response was needed, operators (especially those of higher rank) often chose to audio chat to a subgroup. ("Heads up. There are two actions heading our way, take a look.") Those in the selected chat room would hear the spoken communication immediately through their headsets and redirect their attention. Unfortunately, if their headsets were off or they were away from their stations, they missed the information and had no way of even knowing they had missed it.

Face-to-face conversations were preferred when people were trying to convince or influence another, when they were having difficulty resolving something ambiguous, or when a topic was difficult to explain. Unfortunately, as already discussed, face-to-face is time-consuming, distracts people from the other modalities, and is not possible for distributed teams.

Machine to Machine and Loss of Context

Although technology such as machine to machine transfer is invaluable for speeding transmission and avoiding errors from manual entry, there are complexities to address involving the intersection of technology and human decision making processes. For instance, when operators received data via machine to machine transfer rather than from another member of the team, they could lose the ability to infer important contextual information such as the data's source, pedigree, and why it was being provided at that time. As a consequence, operators sometimes found it necessary to reconstruct some of that meta-information in order to judge the information's validity, provenance, and relevance, and determine how to proceed.

We also observed operator frustration when they saw automatically generated inputs overwrite their manual inputs to a system; in one instance the rows were being reordered as an operator tried to select and edit one on his screen. In another instance, machine to machine inputs overwrote priorities an operator had recently entered. During an interview, one individual commented, "Operators wanted machine to machine, but got more than they asked for: human decision-makers were not always in the loop. Sometimes retasking started without them…" Clearly new technologies will disrupt familiar decision making processes -- hopefully en route to making them more efficient -- but we must plan and train for these changes.

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[5] CIP = Chat in Private

CONCLUSION

In <u>Cognition In The Wild</u>, Hutchins talks about the "cognitive functional system" composed of both humans and technology.

> *"…the computational power of the system composed of person and technology is not determined primarily by the information-processing capacity that is internal to the technological device, but by the role the technology plays in the composition of a cognitive functional system."*
> (Hutchins, 1995, p155)

This paper described some of the contributions that humans make to this "cognitive functional system." It also documents some of the challenges inherent in making the collaboration of humans and technology, as well as the collaboration with one another, as effective as possible in complex environments. As Brown and Duguid aptly note, "Some futurists seem continuously anxious to replace humans…in certain tasks without quite appreciating how people accomplish those tasks. In general, it will be better to pursue not substitution but complementarity…[which] requires seeing the differences between information-processing agents and human agency" (p.62).

ACRONYMS

BDA	Battle Damage Assessment
CIP	Chat in Private
ROE	Rules of Engagement
RTB	Return To Base
TST	Time-Sensitive Targeting
UAV	Unmanned/Unpiloted Aerial Vehicle

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Team Decision Making in Time-Sensitive Environments

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Problem

- Greater complexity, increased reliance on teams
- Human decision making is often the 'long pole in the tent'

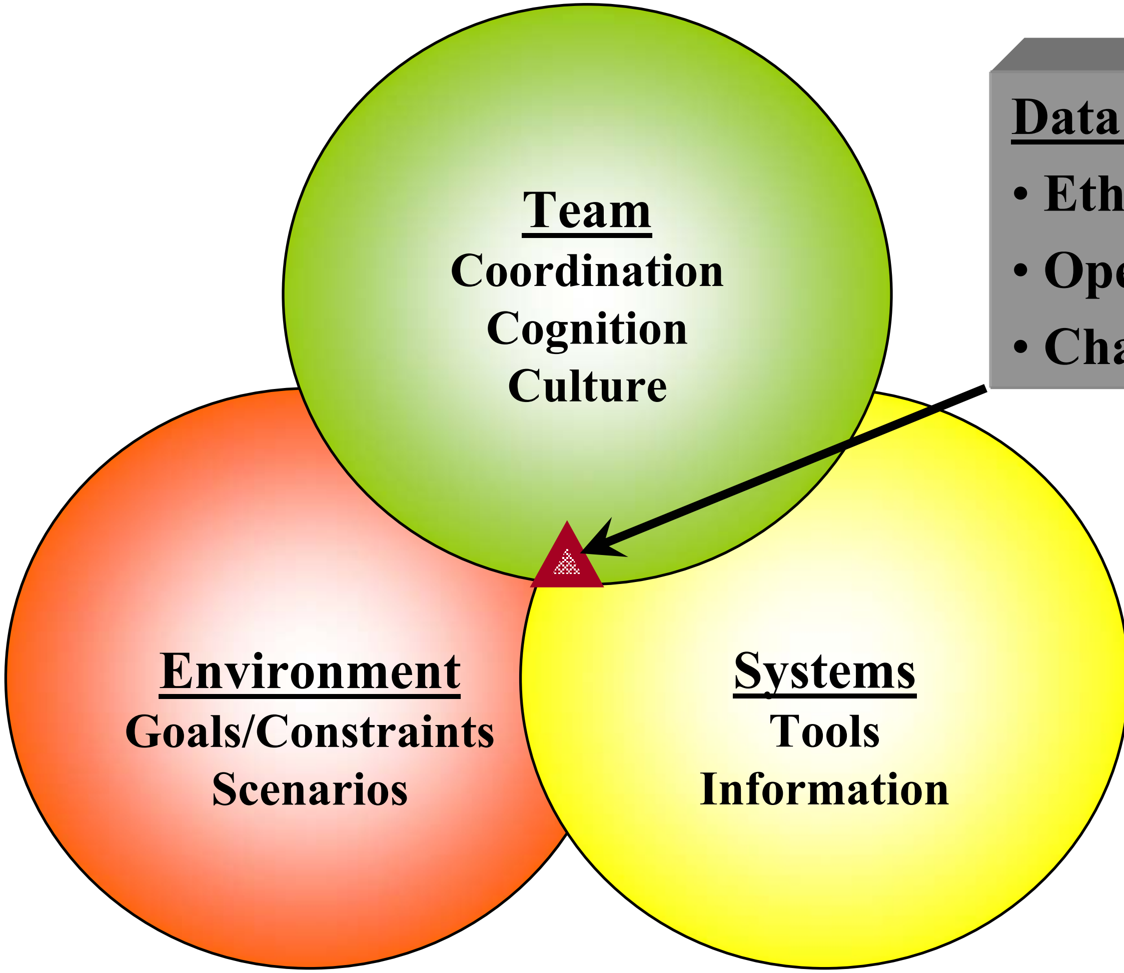
Impact

“Some futurists seem continuously anxious to replace humans… In general, it will be better to pursue not substitution but complementarity… [which] requires seeing the differences between information-processing agents and human agency.”

From Brown and Duguid (2000), The Social Life of Information. Boston, MA: Harvard Business School Press.

- **Understand “human agency” to enable complementarity between humans and information technology**
- **Human adaptations, emergent behavior**
  - **can reveal unmet needs for effective collaboration in complex environments**

Collaboration: Challenges for Data Collection, Measurement & Analysis



Data Collection Methodology

- Ethnographic Observation
- Operator Interviews
- Chat Logs

Goal: Study Human Teams *with* Technologies *in* Rich Environment

Setting the Stage:
A Glimpse of Team *with* Systems *in* Context

Example of 2 minutes with Cell Chief:

- *Text* chats in private to an individual regarding a possible leadership target
- *Audio* chats with someone else to ask why they're working a target
- Starts another audio conversation
- Accepts a text chat message requesting *chat in private*
- Accepts another private chat going about priorities ("Is this urgent?")
- Uses audio chat to give entire team a heads up ("There are two actions heading our way, take a look.")
- At the moment, he has three private chats going, plus the 8 regular chat windows, then audio chat comes in for him…
- Initiates a follow-up audio chat to another individual. Gets no reply, so text chats in private: "Call me *on the headset* or *visit me*…"
- Meanwhile, gets a different kind of text message from left screen application…

[Note: This is all separate from target list application, email messages, face-to-face conversations, public announcements, wall displays…]

Attention Management: "Where do I focus my attention?"

- **Operator juggled 8+ chat windows on right screen alone:**
  - Hears "ping" for an incoming chat message, "But which room is it in?"
  - Adaptation: highlights most recent message in each window; new messages appear unhighlighted, easy to spot (but must repeat…)

- **Self-organize to cue others:**
  - To returning TST Chief:
  - "You missed lots of chat on…" (indicates target and chat room)

Technology could better support human focus

MITRE

Information Sharing: "Who else should see this?"

- Chief audio chats regarding leadership target
  - "Why are you working it? Stop – it's a misdirect. Target is 'in the background'… Don't work it until it's pushed to you."

- Adaptation to avoid misdirecting others
  - TST Chief's left screen displays target information on AOC data wall
  - Until sure of ID, he enters some targets as hidden rows

More information sharing isn't always desired

Managing Relationships for Speed of Command

Teams of Teams

- In one scenario, Air and Land Component Commanders coordination key
- TST Chief proactively monitored LCC’s indicator on stoplight chart and communicated with them even when no action needed. Reported wanting to “get them energized,” ensure buy-in and coordination “*before* it’s a TST”

Challenge increases if crossing organizational boundaries

Observation Highlights from Time-Sensitive Command & Control Events

Teams Manage Complex, Fluid Environment

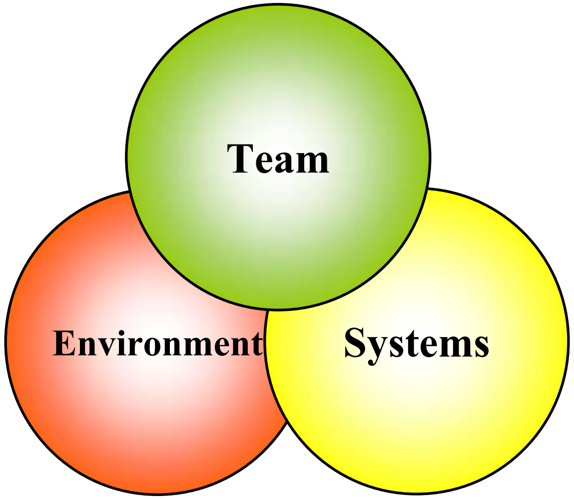
- manage attention
- cue others
- handle ambiguity

Teams Manage Information

- determine reliability of information
- determine who should see what, and how

Teams Manage Team Dynamics

- coordinate roles, priorities
- establish trust, credibility, buy-in
- maintain team awareness
- develop shared situation awareness



Teams Manage More Than Information